Japanese Patent Publication No. 53-126367

1. TITLE OF THE INVENTION: A method to produce a glass fiber interior material

2. CLAIM

A method to produce a glass fiber interior material by pressurizing and heating a glass fiber mat to which uncured binder is added, the method comprising:

providing a set of metal molds which are arranged so as to form, in the internal(center) area of the interior material surface, at least one high density concave part having predetermined shape and a density of 200-500 kg/m^3 and at least one low density convex part surrounding the at least one high density concave part and having a density of 150-80 kg/m^3 and, in the peripheral area of the interior material surface, a high density concave part surrounding the at least one low density convex part and having a density of 200-500 kg/m^3, wherein the entire circumference of the at least one low density convex part is substantially surrounded by the high density concave part, and wherein, for any arbitrary point in the at least one low density convex part, there is at least one point which belong to the high density concave part in each of four directions from the arbitrary point within the distance ℓ which is obtained by the next formula

$\ell = k \times D\ell (Dh - D\ell)$

herein,

ℓ: length or distance (mm)

Dh: Density of high density concave part (kg/m^3)

$D\ell$: Density of low density convex part (kg/m^3)

k: a constant number (0.01 to 0.02);

pressurizing and heating by utilizing the metal molds.

3. DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to the method for manufacturing the glass fiber interior material, particularly the interior material having concave-convex patterns in large size.

Mineral matter interior material having concave-convex patterns in large dimension of about 5 cm or more, for example, ceiling board, can give

gorgeous impression and at the same time, it has noncombustibility and is preferable as interior material. This type of interior material was conventionally manufactured by subjecting the original sheet having a certain density and thickness to a cutting process. However, the above cutting method is not only troublesome but it also decreases the strength of concave parts to be cut down; in addition, it easily develops a crack from the proximity of cutting boundary surface by the notch effect and it becomes necessary to back up the whole of the back of interior material to compensate the decreased strength, thus increasing the weight of interior materials per unit area, and when such interior material is used for the ceiling, there were drawbacks such as the need to obtain great strength of beams.

Attempts were made to save the trouble of cutting process by using the mold having predetermined concave-convex patterns to pressurize and heat the glass fiber mat so that the density of each parts are inversely proportional to the thickness and so that the decrease of the strength in concave parts due to the thinning of thickness is compensated by increasing the density of concave parts. In this method, wrinkles will be formed on the convex parts which maintain low density to provide sound absorbability and heat insulating property, and it becomes necessary to carry out smoothing process on the surface in order to use the material as the interior material.

Larger the size (area) of the convex parts, the greater the chance that wrinkles will occur. When many small concave-convex are in proximity with each other, they are not very apparent even if some of them occur, and it would not ruin the aestheticity. Therefore, this method (direct forming method) can produce interior material having small concave-convex but it would be extremely difficult to produce interior material having large concave-convex without wrinkles.

In order to solve such problems and to manufacture the interior material having concave-convex in large sizes without wrinkles by the direct forming method, the present inventors conducted considerable amount of studies. As a result, the present inventors propose the present invention which has been ascertained to be advantageous.

The present invention is a method to produce a glass fiber interior material by pressurizing and heating a glass fiber mat to which uncured binder is added, the method comprising:

providing a set of metal molds which are arranged so as to form, in

the internal area of the interior material surface, at least one high density concave part having predetermined shape and a density of 200-500 kg/m^3 and at least one low density convex part surrounding the at least one high density concave part and having a density of 150-80 kg/m^3 and, in the peripheral area of the interior material surface, a high density concave part surrounding the at least one low density convex part and having a density of 200-500 kg/m^3, wherein the entire circumference of the at least one low density convex part is substantially surrounded by the high density concave part, and wherein, for any arbitrary point in the at least one low density convex part, there is at least one point which belong to the high density concave part in each of four directions from the arbitrary point within the distance ℓ which is obtained by the next formula

$$\ell = k \times D\ell\,(Dh - D\ell)$$

herein,

ℓ: length or distance (mm)

Dh: Density of high density concave part (kg/m^3)

Dℓ: Density of low density convex part (kg/m^3)

k: a constant number (0.01 to 0.02);

pressurizing and heating by utilizing the metal molds.

Next, the present invention will further be explained in detail.

In the present invention, the uncured glass fiber mat, which is produced by spraying glass short fibers manufactured by centrifugation, fire flame method, etc. with binder and then accumulating the glass short fibers on the perforated conveyer, is used as the glass fiber mat. The type of binders is not limited; for example, binders of phenolic resin type, urea resin type, and melamine resin type can be used. The appropriate amount to be used is about 7-15 wt % to the glass fibers as a solid content. The thickness of the mat (weight per unit area) is determined according to the thickness and density of the desired interior material but those having a thickness of about 0.3-2 kg/m^2 are normally used.

Mat is put on a lower mold 3 having concave-convex, which corresponds to concave-convex on the interior material surface, on a predetermined position. The mat is then pressed with an upper mold 4, and during the press the heating is conducted.

In this instance, the distance between the lower mold 3 having concave-convex and flat upper mold 4 is determined so that the density of

high density concave parts 1 is between 200-500 kg/m³. By setting the density of concave parts within this range, a sufficient strength is provided to the concave parts, and furthermore, no wrinkles will be formed on the concave parts. The glass fibers are compressed with strong force and as a result, the formed wrinkles are crushed and smoothed out.

The distance between the upper mold and lower mold is determined so that the density of low density convex part 2 is between 150-80 kg/m³. The density is set within the above range so as to provide sound absorbability, heat insulating property and strength necessary for the interior material.

When the densities are set within the above range, however, the wrinkles will easily occur on the low density convex part if the concave-convex pattern is large and the resulting interior material cannot be used as it is; it would be necessary to polish the surface. Even when painting the surface or adhering a material for the surface, a beautiful surface cannot be obtained if the surface with wrinkles are used as it is.

As a result of studies to solve the concerned problems, the present inventors found that the occurrence of wrinkles can be prevented by determining the shape of the mold so that the low density convex part 2 is surrounded by the high density concave part 1, and that, for any arbitrary point P in the low density convex part, there is at least one point (Q, R, S and T in figure 2) which belong to the high density concave parts in each of four directions from the arbitrary point P within the distance ℓ (ℓ_1-ℓ_4 in figure 2)(mm) which is $k \times D\ell\,(Dh - D\ell)$; and pressurizing and heating the glass fiber mat by utilizing the mold so as to cure the glass fiber mat.

In the formula, Dh and Dℓ are densities of high density concave parts and low density convex part represented in kg/m³. k is a constant number which is determined within the range of 0.01-0.02 according to a type of mat, desired smoothness, etc. The smaller the k, the larger the smoothness (thus, the occurrence of wrinkles are small), and especially preferable result can be obtained by k = 0.01.

Although the mechanism of the present invention is not sufficiently clear, as a result of the high pressurization of the high density parts, the mat surface of low density part are stretched as in the arrow X and Y in Fig. 2 toward the high density parts by the mold parts that press the high density parts. In this state where the tensile forces are applied, the pressurization and heating are conducted. The tensile forces become greater toward the

proximity of the high density parts. As the low density part is surrounded by the high density parts, all point P belonging to the low density part are pressurized in a tense state where they are pulled from four directions. As this tensile forces become greater as it distances itself from the center part of the low density part (as it nears the high density parts), it is considered that pressurization and heating are carried out without occurrence of sagging on the mat surface, and thereby the occurrence of wrinkles is prevented as well. The tensile force acting on the low density part tend to become less as the distance between the low density part and the high density parts becomes longer. The tensile force acting on the low density part tend to become greater as the difference in height of the surface, which relates to the difference in the density, between the low density part and the high density parts becomes greater. Furthermore, wrinkles tend to easily occur as the density of the low density part becomes lower. As a result of the experiment, it was found that the wrinkle occurrence can be prevented by setting ℓ equal to or less than $k \times D \ell (D h - D \ell)$. If ℓ is too large, the wrinkle occurrence cannot be sufficiently prevented.

According to the method of the present invention, a light-weight interior material having concave-convex of about 50 cm or more with no wrinkles can easily be manufactured without finishing the surface by polishing. Thus, the present invention is industrially useful. However, the present invention is not limited to the above explanations and following example; it can be changed as appropriate within a range that do not depart from the purpose and the spirit of the present invention. For example, the interior material manufactured by the method of the present invention can be subjected to the finishing such as surface painting and other processing. Or, the interior material manufactured by the method of the present invention can be cut as appropriate so that the ends become the low density part. Furthermore, a plurality of independent low density part and high density parts can be formed as well.

The density of the low density part and high density parts may not be constant but different depending on places. A plural of internal high density parts may be formed. In the internal area, high density parts may be formed as shown in figure 3, not at the center as shown in figure 1.

An example of the present invention is shown below.

A glass fiber mat with 10 wt % binder contents (as a solid content),

1.2 kg/m^2, thickness of 12 mm is obtained by spraying phenolic binder on the glass short fibers manufactured by centrifugation and then accumulating them on the perforated conveyer. The glass fiber mat is pressurized by molds 3 and 4 as shown in Fig. 2 and heated for one minute at 250 °C to be cured. As a result, a ceiling board without wrinkles is obtained.

The dimensions of the ceiling board at this example are as follows:

High density concave part in the internal area

Size 75 mm x 100 mm

Thickness 3 mm

Density 400 kg/m^3

Low density convex part

The size of the outer circumference 225 mm x 300 mm

Thickness 12 mm

Density 100 kg/m^3

High density part in the peripheral area

Width 10 mm

Thickness 3 mm

Density 400 kg/m^3

The maximum value of ℓ_1, ℓ_2, ℓ_3 and ℓ_4 in the present example is 300 or less, 0.01x100x(400-100) = 300.

4. BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows one example of the glass fiber interior material manufactured by the method of the present invention, Fig. 2 is a cross-sectional view of A-A direction showing the method for manufacturing the interior material of Fig. 1, Fig. 3 is a plain view similar to Fig. 1 but showing other examples of the present invention.

1 represents high density parts, 2 represents low density part, 3, 4 represents mold, 5 represents uncured glass fiber mat.

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㊽硝子繊維内装材の製造法

㉑特　　願　昭52—39428

㉒出　　願　昭52(1977)4月8日

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明　細　書

1.発明の名称　硝子繊維内装材の製造法

2.特許請求の範囲

未炭化の結合剤を附与した硝子繊維マットを加圧、加熱して内装材を製造するに際し、内装材表面の内域に所定形状の密度200〜500 Kg/m³の内域高密度凹部と内域高密度部を囲む密度150〜80 Kg/m³の低密度部を形成せしめるとともに、この低密度部を囲んで密度200〜500 Kg/m³の周縁高密度凹部を形成せしめるよう、且つ低密度凸部は高密度凹部で実質的にその全周を囲繞され、又低密度凸部の任意の点に対し次式で求められる距離 ℓ 以内に略々4方向に少くとも各一つの高密度凹部に属する点が存在するよう金型を配設し、この金型を使用して加圧、加熱を行なうことを特徴とする硝子繊維内装材の製造方法

$$\ell = k \times D\ell\,(Dh - D\ell)$$

但し

ℓ：距離　（%）

Dh：高密度凹部の密度（Kg/m³）

$D\ell$：低密度凸部の密度（Kg/m³）

k：常数　（0.01〜0.02）

3.発明の詳細な説明

本発明は硝子繊維内装材、特に大きな寸法の凹凸模様を有する内装材の製造方法に関するものである。

5 cm程度乃至それ以上の大きなディメンションの凹凸模様を有する、鉱物質内装材例えば天井板は豪華な感じを与えることができ、且つ不燃性を有し内装材として好適なものである。この種内装材（凹凸内装材という）は従来一定密度、一定厚みの原板を切削加工することによって製造されたが、上記方法（切削法と云う）は手数を要するばかりでなく切削される凹部の密度が低下し、又切削境界面附近からノッチ効果によって亀裂が発生しやすくなり、更に又強度低下を補うため内装材裏面全体に裏打ちをする必要が生じ、このため内装材単位面積当りの重量が増加し、この内装材を天井に用いた場合第

強度を大きならしめることを要する等の欠点があつた。

硝子繊維マットを所定の凹凸模様を有する金型を使用して加圧、加熱して、各部分の密度を厚みに逆比例せしめることにより、切削加工の手間を省き、且つ厚みを小さくしたことによる凹部の強度低下を凹部の密度を大きくすることにより補うことも試みられたが、この方法によるときは、所望の吸音性、断熱性を与えるため密度を低く保つた凸部に皺が発生し、内装材として使用するためには表面を平滑加工する必要が生ずる。

皺の発生は凸部の大きさ（面積）が大きい程大きくなる傾向があり、又小さい凹凸が多数近接して配置されている場合は皺が若干発生しても余り目立たず、美観を損うこともないので、この方法（直接成型法という）では、小さい凹凸を有する内装材を製造することはできても、皺のない大きい凹凸を有する内装材を製造することは極めて困難である。

本発明者はかかる難点を解決し、直接成型法によつて、皺のない、大きい寸法の凹凸を有する内装材を製造する為検討を重ねた結果未硬化の結合剤を附与した硝子繊維マットを加圧、加熱して内装材を製造するに際し、内装材表面の内域に所定形状の密度２００～５００Kg/m³の内域高密度凹部と内域高密度部を囲む密度１５０～８０Kg/m³の低密度凸部を形成せしめるとともに、この低密度凸部を囲んで密度２００～５００Kg/m³の周縁高密度凹部を形成せしめるよう、且つ低密度凸部は高密度凹部で実質的にその全周を囲繞され、又低密度凸部の任意の点に対し次式で求められる距離ℓ以内に縦横４方向に少くとも各一つの高密度凹部に属する点が存在するよう金型を設計し、この金型を使用して加圧、加熱を行なうことを特徴とする硝子繊維内装材の製造方法。

$\ell \fallingdotseq x \times D\ell\,(Dh - D\ell)$

但し

ℓ：距離（%）

Dh：高密度凹部の密度（Kg/m³）

Dℓ：低密度凸部の密度（Kg/m³）

x：常数（0.01～0.02）

ことにより極めて好適な結果の得られることを見出し本発明として提案したものである。

次に本発明を更に具体的に説明する。

本発明において硝子繊維マットとしては、遠心法、火焔法等によつて製造された硝子短繊維にバインダを噴霧し、有孔コンベヤー上に集積した未硬化硝子繊維マットを使用する。バインダの種類に特に限定はなく例えばフェノール樹脂系、尿素樹脂系、メラミン樹脂系バインダが使用できる。その使用量は固形分として硝子繊維に対し７～１５重量％程度とするのが適当である。マットの厚み（単位面積当りの重量）は所望の内装材の厚み、密度に応じて定められるが、通常０.５～２Kg/m²程度のものが用いられる。

マットは所定位置に内装材表面凹凸に対応する凹凸を有する下方金型３上に載置し、上方金型４で挟圧、この間に加熱を行う。

この際高密度凹部１は密度が２００～５００Kg/m³とするよう凹凸を有する下方金型３、平坦な上方金型４間の距離を定める。凹部の密度をこの範囲に定めることにより、凹部に充分な強度を与え、しかも凹部に皺が発生することはない。硝子繊維が強く圧縮される結果、発生した皺が圧縮され、平滑化されるものと思われる。

低密度凸部２は密度が１５０～８０Kg/m³となるよう上方、下方金型間の距離を定める。内装材に必要な吸音、断熱性及強度を与えるために密度を上述の範囲とする。

しかしながら密度を上述の範囲とすると凹凸模様が大きい場合低密度凸部に皺が生じ易く、内装材としてそのまま使用することはできず、表面を研磨する必要が生ずる。表面に塗装し、或は表装材を貼着する場合でも皺のある面をそのまま使用すると美麗な表面をうることはできない。

本発明者はかかる難点を解決する為検討を重ねた結果、低密度凸部２を高密度凹部１で囲繞

し且つ低密度凸部の任意の点Pに対しPとの距離（第2図では ℓ_1〜ℓ_4 (cm)）が $K \times D\ell\,(Dh-D\ell)$ より小さい高密度凹部に属する点（第2図ではQ、R、S及びT）がPの垂直四方向に少くとも各1つ存在するよう金型の形状を定め、この金型を用いて硝子繊維マットを加圧しつつ加熱し、硬化せしめることにより皺の発生を防止しうることを見出した。

なお式中Dh、Dℓは Kg/m³ で表わした当該高密度凹部及低密度凸部の密度、Kは常数でマットの繊維所望の平滑度等に応じて0.01〜0.02の範囲で定められる常数である。Kを小とする程平滑度は大（従つて皺の発生は小）となり $K=0.01$ とすることにより特に良好な結果をうることができる。

本発明の作用については充分明らかではないが、高密度部が強く圧縮される結果、高密度凹部に対応する金型により低密度部に対応するマット表面が高密度部に向け第2図矢印X、Yのように引張られ張力を受けた状態で加圧、加熱される。しかもこの引張り力は高密度部に近い部分程大きく又低密度部は高密度部で囲まれているので、低密度部に属する点Pはすべて四方向から引張られて緊張した状態で加圧され、しかもこの引張り力は低密度部の中心部から離れる程（高密度部に近い程）大となるので、マット表面にたるみが生ずることなく加圧、加熱され皺の発生が防止されるものと思われる。尚、この低密度部の受ける引張り力は該低密度部と高密度部との距離が大となる程小となり又低密度部と高密度部の密度の差に起因する表面部の高さの差が大きくなる程大となる傾向があり更に又低密度部の密度が小さい程皺が発生しやすくなる傾向があり、実験の結果 $\ell \leqq K\,D\ell\,(Dh-D\ell)$ とすることにより皺の発生が防止しうることが見出された。ℓがあまり大きいと皺の発生を充分防止することはできない。

本発明の方法によるときは50㎝程度以上の凹凸を有する皺のない模様の内装材を研削による表面仕上げを施こすことなく容易に製造することができ、本発明は工業上有益なものであるが、本発明は上述の説明及以下の実施例に限定されることなく、本発明の目的及精神を逸脱しない限度において適宜変更できるものである。例えば本発明の方法によつて製造した内装材に表面塗装等の仕上げ、加工を施して使用してもよく、又、本発明の方法によつて製造された内装材を適宜切断し、端部が低密度部となるようにしてもよい。更に又、独立した低密度部、高密度部を多数設けることもできる。

尚、又例えば低密度部、高密度部の密度を一定とせず、場所によつて密度を異ならしめてもよく、或は内域高密度部を複数個設け或は第1図に示すように内域高密度部を幾何学的中心部に設けることなく第3図に示すように配置してもよい

次に本発明の実施例を示す。

遠心法によつて製造された硝子短繊維にフェノール系バインダを噴霧しつつ有孔コンベヤー上に集綿して得られたバインダー含有量（固形分として）10重量%、1.2Kg/m²、厚み12㎜の硝子繊維マット5を第2図に示すような金型3,4で加圧しつつ250℃に1分間加熱して硬化せしめ皺のない天井板をうることができた。

この際の天井板のディメンションは次の通りである。

内域高密度凹部
- 大きさ　75㎜×100㎜
- 厚み　5㎜
- 密度　400 Kg/m³

低密度凸部
- 外周の大きさ　225㎜×300㎜
- 厚み　12㎜
- 密度　100 Kg/m³

周縁高密度部
- 巾　10㎜
- 厚み　5㎜
- 密度　400 Kg/m³

なお、本実施例における $\ell_1, \ell_2, \ell_3, \ell_4$ の最大値は300以下、$0.01 \times 100 \times (400-100) = 300$

である。

4.図面の簡単な説明

第1図は本発明の方法によつて製造された硝子繊維内装材の一つの実施例を示す平面図、第2図は第1図の内装材の製造方法を示すA－A方向の断面図、第3図は本発明の他の実施例を示す第1図と同様な平面図である。

図中1は高密度部、2は低密度部、3，4は金型、5は未硬化硝子繊維マットを示す。

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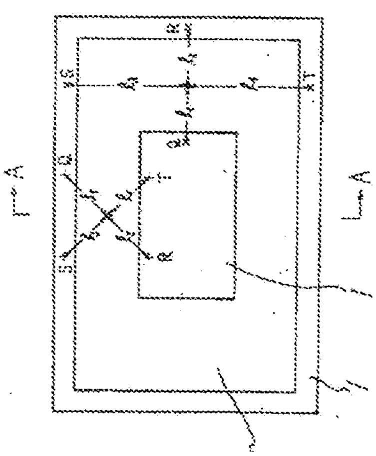
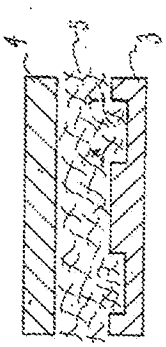
第1図



第2図



第3図